

Synergizing Software Engineering and AI: A Sustainable Intelligent Model for Automating Higher Education Quality Assurance Auditing

Ibrahim Ahmed Al-Baltah

Department of Information Technology, Faculty of Science and Engineering, Al-Hikma University, Sana'a, Yemen.
albalta2020@gmail.com

RECEIVED:00/00/2024

REVISED : 00/00/2024

ACCEPTED : 00/00/2024

PUBLISHED :00/00/2023



THIS WORK IS LICENSED
UNDER A [CREATIVE
COMMONS ATTRIBUTION
4.0 INTERNATIONAL
LICENSE.](#)

Abstract:

Higher education quality assurance is a very important task for improving the quality of education, which needs regular auditing. This auditing process requires a lot of manual work to evaluate the higher education institutions against quality assurance standards, guides, and forms. Therefore, this paper aims to propose a new AI-based model to automate the auditing process and to ensure as accurate results as possible when needed. This model utilizes artificial intelligence and software engineering. The software architecture of the proposed model consists of three layers that systematically interact with each other to achieve the model goal.

Keywords: Artificial intelligence, software architecture design, quality assurance, auditing, natural language processing, deep learning.

1. Introduction

Artificial Intelligence (AI) is a concept that started a long time ago and gradually became a very important and yet very popular and active field [1]. AI technology is no longer a research subject, rather it is an integral component model for most sectors such as finance, medicine, manufacturing, education, and others [2]. AI has a great power of decision making that helps business processes to take better action to ensure obtaining and achieving optimal competitive advantages. Higher education quality assurance is not an exception; it utilizes many technologies to improve the quality of education at different levels. The utilization of AI in education will significantly impact education from kindergarten education level to the highest postgraduate level (Alasmari, 2023) [3].

According to (Omer, 2024)[4], the process of the Council for Accreditation and Quality Assurance (CAQA) evolves some processes to control and develop the required higher education standards, guides, and forms to improve the output quality of the education service.

However, researchers have tried to investigate the role and impact of AI on higher education quality assurance (Al-Ghobesi, 2025, Ahmed, 2025)[5]. Meanwhile, others are utilizing software engineering during the development of software that is used in higher education quality assurance. Therefore, this paper aims to fill the existing gap through the consideration of these three areas and reveal the possible advantages of their utilization. Moreover, it aims to propose a new AI-based model for automating the process of quality assurance auditing that CAQA and higher education institutions could benefit from. This is because using AI and software engineering could yield a good combination that can help in improving the quality of services.

Current software systems combine several components and technologies from different fields. For example, automatic student assessment is made up of different components including IoT devices, AI algorithms, and other components. From a technical point of view, those components are not separate, hence, they are working together in a harmonized way, which could be achieved through software engineering. Software engineering plays a crucial role in developing and delivering high quality large systems [6], where auditing quality assurance is one of them.

Nonetheless, the authors of [7] presented a detailed case study on sustainable quality assurance at Prince Sultan University. They proposed a data warehouse for accreditation from a theoretical perspective. Yet, they ignored the auditing process. On the other hand, [4] proposed an internal quality assurance system based on AI that aimed at increasing the chance of accreditation; consequently, improving the quality of graduations.

However, the main purpose of this paper is to propose a new sustainable AI-based model for automating the process of auditing higher education quality assurance called AI-HEQA. This is due to the fact that CAQA and the higher education institutions are still conducting the auditing task manually, and thus needs a lot of effort. Therefore, AI-HEQA aims to produce instant and accurate auditing results with less effort.

The remainder of this paper is organized as follows: section 2 presents the proposed model. Section three presents the system architecture design of AI-HEQA from a software engineering point of view. Section four concludes the paper.

2. The proposed AI-based model

According to [8], automating the auditing process through the utilization of AI technologies can sharply reduce the required manual work and yield effective results with less cost. As mentioned earlier, the main goal of this paper is to propose a sustainable model that aims at automating the process of auditing higher education quality assurance. This main goal can be divided into two sub-goals. This first one is to help CAQA easily and instantly investigate to what extent higher education institutions are adhering to the imposed standards, guides, and forms by CAQA through visual representations and detailed reports. Meanwhile, CAQA can make a realistic decision based on the data that has been collected from the higher education institutions and processed by AI-HEQA. The second sub-objective is to help higher education institutions to monitor themselves and instantly identify the standards, guides, and forms that are not fully applied to improve their quality.

This model AI-HEQA consists of the following main steps:

- a. **Defining Objectives and Criteria:** The main objective of the proposed model is derived from the objective of quality assurance auditing. In fact, the main objective of the auditing process is not only to identify and inform the higher education institutions of their deviations from the stated standards; it is rather meant for monitoring the progress of education quality by highlighting the main shortcomings that should be efficiently addressed to improve the education quality. This improvement will certainly improve the quality of the institution's outputs including students' knowledge and skills, which have direct impacts on our society and environments. On the other hand, it aims at helping quality assurance and the institutions to take the right actions when needed based on the information generated by AI-HEQA.
- b. **Data Collection:** Data is the vital input for any AI model which are used for training and testing the model. This data should be collected from two sources where CAQA is the first source, in which standards, guides, forms, and other data relevant to quality assurance are collected. On the other

hand, the second data source is the higher education institutions, which have to provide the curriculums, institutional reports, programs' infrastructures, staff, and other related data. It is important to mention that, data collection should be carried out carefully and by specialists to ensure the quality of the collected data, which will certainly affect the results of the proposed model.

- c. **AI Model:** From among different AI models, natural language processing (NLP) and deep learning (DL) are chosen. The reason for choosing NLP is that NLP has the power to deal with textual data [9], which represents most of the quality assurance data. Meanwhile, DL is used to develop predictive models to help the auditors efficiently and effectively identify the possible deviation from the standards, guides, and forms that are being stated by the CAQA. Therefore, the auditing process should be formulated and encoded into the AI model.
- d. **Model Training:** After the construction of the proposed model, it is mandatory to sufficiently train the model until it obtains acceptable results. AI-HEQA should have sufficient learning to recognize patterns and relationships between features of the different forms of data. The training data should be prepared carefully and should cover all types of data to help the model generate as accurate results as possible.
- e. **Model Validation and Evaluation:** Before deploying the model to the execution environment, it has to pass the validation and evaluation process. This is done by using testing data, which should be different from the training data to judge its ability to process unseen data to be generalized. For evaluating the performance of the proposed model, some relevant metrics shall be used such as accuracy, precision, recall, and F2 score [10].
- f. **Interpretability and Explainability:** To make the auditing process using the AI-HEQA model easy and smooth, the produced results should be clear, easy to understand, and yet interpretable. Besides, the results should also be explainable in such a way that stakeholders can understand them correctly. This is a very important step to ensure a unified understanding and explanation, and thus, different stakeholders arrive at common decisions and conclusions. Without contradiction of interpretation and explanation of the model's results, it could help quality assurance to make suitable decisions with confidence.
- g. **Feedback and continuous improvement:** To increase the trust of the stakeholders, the proposed model must be regularly improved continuously. This improvement is based on the feedback given by the CAQA experts and the higher education institutions. Despite the power of AI technology, the produced results by AI-HEQA should be further investigated by experts continuously to identify

possible improvements. Continuous feedback is very important to ensure the **sustainability** of AI-HEQA.

3. System architecture design of AI-HEQA from the software engineering point of view

According to the European Middle Market Report 2H 2015 [11], and U.S. Middle Market Report Q4 2015 [12], the rate of building unsuccessful software products is 75%, which wastes 322 billion USD of companies capital. Therefore, it is very important to adopt the best practices of software engineering to increase the rate of success of the proposed model. From a software engineering perspective, the suitable system architecture design of AI-HEQA consists of different layers as illustrated in Figure 1.

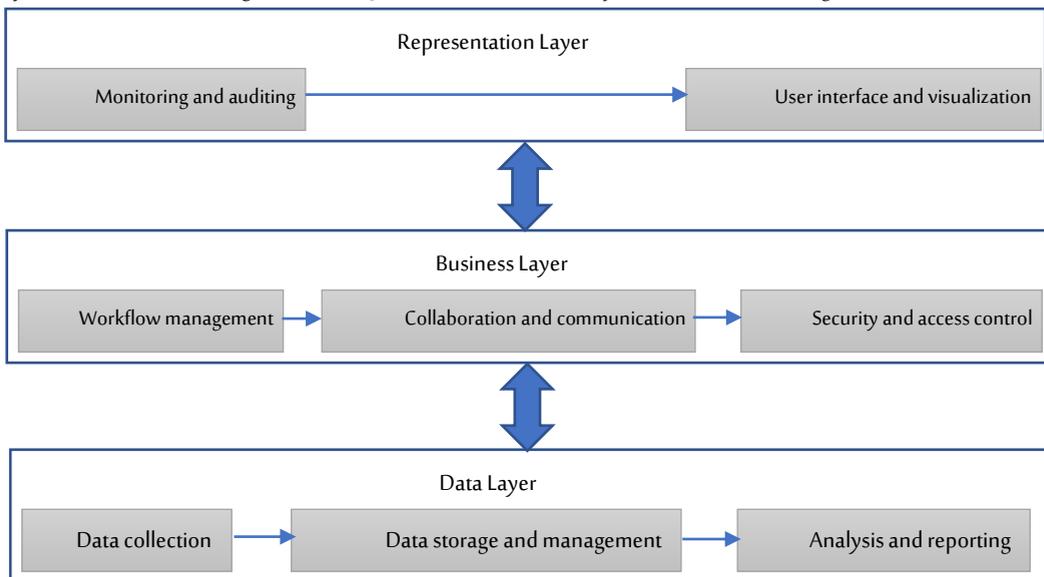


Figure 1: system architecture design of AI-HEQA

As can be shown in Figure 1, the proposed model consists of three main layers including representation, business, and data layer. It is worth pointing out that, the AI components are not isolated in a separate layer; instead, they are integrated into each layer to support different aspects of the auditing process.

- a. **Data Layer:** it is the fundamental layer for the proposed model, which is responsible for collecting data from different sources, and storing and managing the collected data related to the auditing process. It has the capabilities to perform data analytics and generate the required reports.

Data should be collected from CAQA and higher education institutions. During this process, the data collection component should employ unified data formats and ensure data integrity.

Furthermore, the output of this component is clean data without contradiction, which is valid for storage to be used for the auditing process.

The data storage and management component are responsible for storing the data that were generated from the data collection component, organizing this data for efficient use, and retrieving the stored data. A centralized repository is recommended at CAQA where other parties can have the right access to the right data only.

The last component in this layer is analysis and reporting. This component has the capability to perform intelligent data analytics to extract meaningful insights from the collected data. These insights are crucial for making the right auditing decisions. Moreover, this component is capable of generating comprehensive reports that provide quality assurance with very important information that presents to what extent the higher education institutions have adhered to the quality assurance standards, forms, and guides. Additionally, it identifies and highlights some points for quality improvement.

- b. **Business layer:** it is a middle layer, in which the presentation layer and data layer communicate through it. It contains the core business logic of the whole model, including workflow management, collaboration and communication, and security and access control.

The first component of this layer is workflow management. It is the orchestrator for the different components that are involved in the auditing process. The workflow is task-based, in which the automated auditing process is divided into tasks. This could include automated data collection, data storage and management, analysis, and report generation, feedback collection.

The second component is collaboration and communication which consumes the output of the first component to perform its tasks. This component aims to facilitate the process of communication and collaboration among different parties namely: auditors, higher education institutions, and other stakeholders. It should provide sufficient communication and collaboration tools including, email, discussion forums, and chat. It is worth mentioning that, the model could be integrated with Chabot as a technique for communication and feedback collection.

The last component of this layer is the security and access control. This is a very critical component, especially with the daily increase of cyber-attacks. For that reason, it is recommended to apply software security best practices. The ultimate goal of this component is to protect the

collected data from unauthorized access. Therefore, this component is capable of data encryption, user authentication, and access control mechanisms.

- c. **Representation layer:** This layer aims to provide users with interactive user interfaces to easily and smoothly interact with the model. Thus, auditors and stakeholders are able to navigate and access all of the model's functionalities. In addition, it provides a dashboard to display clear and concise charts and graphics that are easily understandable and interpretable by different users. Therefore, auditors can make initial decisions from the data presented on the dashboard. The final decisions can be made after generating detailed reports.

4. Conclusion

To evaluate to what extent the higher education institutions follow quality assurance is a tedious task. As a result, this paper proposed a new sustainable model with the aim of automatizing the process of quality assurance auditing called AI-HEQA. The model utilizes two different fields: AI and software engineering. This model consists of three layers namely the data layer, the business layer, and the presentation layer. Every layer also consists of some components, which are systematically integrated.

In future work, we are planning to develop the proposed model based on the provided system architecture and conduct experimental evaluations to ensure the applicability of the model. Consequently, the model can be deployed in the real environment for real use.

5. References

1. Xu, Y., et al., *Artificial intelligence: A powerful paradigm for scientific research*. 2021. 2(4).
2. Dwivedi, Y.K., et al., *Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy*. 2021. 57: p. 101994.
3. Ocaña-Fernández, Y., L.A. Valenzuela-Fernández, and L.L.J.J.o.E.P.-P.y.R. Garro-Aburto, *Artificial Intelligence and Its Implications in Higher Education*. 2019. 7(2): p. 553-568.
4. Elviwani, M.Z., A. Dilham, and R.J.I.J.S.R.C.S.E.I.T. Buaton, *Higher Education Quality Assurance System Based Artificial Intelligence*. 2020. 3307: p. 274-279.
5. Zawacki-Richter, O., et al., *Systematic review of research on artificial intelligence applications in higher education—where are the educators?* 2019. 16(1): p. 1-27.
6. Van Vliet, H., H. Van Vliet, and J. Van Vliet, *Software engineering: principles and practice*. Vol. 13. 2008: John Wiley & Sons Hoboken, NJ.
7. Javed, Y. and M. Alenezi, *A Case Study on Sustainable Quality Assurance in Higher Education*. 2023. 15(10): p. 8136.
8. Noordin, N.A., K. Hussainey, and A.F. Hayek, *The Use of Artificial Intelligence and Audit Quality: An Analysis from the Perspectives of External Auditors in the UAE*. 2022. 15(8): p. 339.
9. Yogish, D., T. Manjunath, and R.S. Hegadi. *Review on natural language processing trends and techniques using NLTK* in

- Recent Trends in Image Processing and Pattern Recognition: Second International Conference, RTIP2R 2018, Solapur, India, December 21–22, 2018, Revised Selected Papers, Part III 2.* 2019. Springer.
10. Abd El-Haleem, A.M., et al., *A Generic AI-Based Technique for Assessing Student Performance in Conducting Online Virtual and Remote Controlled Laboratories.* 2022. **10**: p. 128046-128065.
 11. I, P.D., *European Middle Market Report 2H 2015.* 20215.
 12. I, P.D., *U.S. Middle market report Q4 2015. Technical report.* 2015.
 13. Alasmari, J. S. . (2023). The Dynamics of Verbal and Non-Verbal Linguistic Communication in The Saudi Sports Community. *Arts for Linguistic & Literary Studies*, 5(4), 539–569. <https://doi.org/10.53286/arts.v5i4.1676>
 14. Ahmed, M. R. A. (2025). Accreditation and Quality Assurance: Exploring Impact and Assessing Institutional Change in the US and Saudi Arabian Higher Education Institutions. *Arts for Linguistic & Literary Studies*, 7(1), 626–639. <https://doi.org/10.53286/arts.v7i1.2419>
 15. Al-Ghobesi, A. A. H. (2025). Risks of Relying on Artificial Intelligence in Learning Arabic Language Sciences Through the Meta Application. *Arts for Linguistic & Literary Studies*, 7(1), 396–419. <https://doi.org/10.53286/arts.v7i1.2420>
 16. Omer, N. I. M. (2024). Maintaining Meaningful Human Interaction in AI-Enhanced Language Learning Environments: A Systematic Review. *Arts for Linguistic & Literary Studies*, 6(3), 533–552. <https://doi.org/10.53286/arts.v6i3.2083>